

## Title: Differential and Functional Interactions Emphasize Multiple Roles of Polyamines in Plants

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### Abstract:

Polyamines represent a ubiquitous class of biogenic amines implicated in regulating cellular processes of most organisms. Much attention has focused on the diamine putrescine (Put) and higher polyamines, spermidine (Spd) and spermine (Spm). Generally, it has been assumed that these three amines have similar biological effects but with differing amplitudes. We are using transgenic approach to discern the independent roles of Put, Spd and Spm, and have developed transgenic tomato plants homozygous with yeast polyamine biosynthesis genes. NMR-based metabolite profiling suggests that Spd and Spm are perceived as ‘signaling’ organic-N metabolites by the fruit cells, revive metabolic memory and stimulate carbon sequestration, enhanced synthesis of biomolecules, and nitrogen use efficiency. Transcriptome analysis revealed a large number of differentially expressed genes, representing discrete functional categories as well as novel pathways: amino acid biosynthesis, carotenoid biosynthesis, cell wall metabolism, chaperone family, flavonoid biosynthesis, fruit ripening, isoprenoid biosynthesis, polyamine biosynthesis, signal transduction, stress/defense related, transcription, translation, and vacuolar function. Thus, multiple cellular pathways in diverse subcellular compartments are impacted. Spd-Spm bring about a nexus between N signaling and carbon sequestration involving a network of anabolism-related genes. Correlation coefficient analysis was used to show that, in most instances, Spd-Spm effects on similar targets were exactly opposite of Put, suggesting that these biogenic amines have independent roles in plant metabolism. Analysis of transcript and metabolite profiles also revealed that Spd-Spm action includes posttranscriptional regulation. To determine the early events in Spd-Spm signaling, we have identified and sequenced gene clusters in tomato genome which are targets of polyamine action and regulate initial events in RNA processing and protein synthesis.

### Further reading:

- Mattoo, A.K. et al. NMR spectroscopy-based metabolite profiling of transgenic tomato fruit engineered to accumulate spermidine and spermine reveals enhanced anabolic and nitrogen-carbon interactions. *Plant Physiol.* 142: 1759-1770. 2006.
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- Neelam, A. et al. A field-grown transgenic tomato line expressing higher levels of polyamines reveals legume cover crop mulch-specific perturbations in fruit phenotype at the levels of metabolite profiles, gene expression and agronomic characteristics. *J. Exp. Bot.* 59: 2337-2346. 2008.
- Mattoo, A.K. et al. Polyamines and cellular metabolism in plants: Transgenic approaches reveal different responses to diamine putrescine versus higher polyamines spermidine and spermine. *Amino Acids*, DOI 10.1007/s00726-009-0399-4. 2009.
- Handa, A.K., and Mattoo, A.K. Differential and functional interactions emphasize the multiple roles of polyamines in plants. *Plant Physiol Biochem*, [doi:10.1016/j.plaphy.2010.02.009](https://doi.org/10.1016/j.plaphy.2010.02.009). 2010.